

科目：流體力學 適用：土木所水利組

編號：502

考生注意：

1. 依次序作答，只要標明題號，不必抄題。
2. 答案必須寫在答案卷上，否則不予計分。
3. 限用藍、黑色筆作答；試題須隨卷繳回。

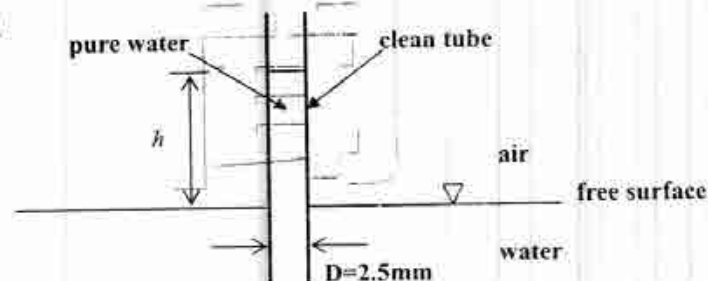
 本試題
共 2 頁
第 1 頁

註：除專有名詞外，請以中文回答。

1. (15%) A 2.5mm-diameter clean tube is inserted in pure water at 15°C, as shown in Fig. 1. Please determine the height that the water will climb up the tube using the following data for pure water, some of which are possibly not useful.

temperature	density ρ (kg/m^3)	Surface tension σ (N/m)	Viscosity μ ($\text{N}\cdot\text{s/m}^2$)
10°C	999.7	0.0748	1.308×10^{-3}
20°C	998.2	0.0736	1.005×10^{-3}

Fig. 1

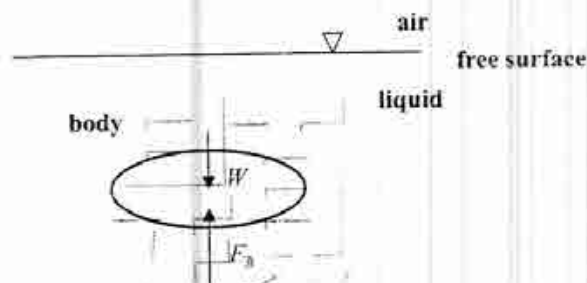


2. (15%) Prove that the Archimedes' principle for an immersed body is (Fig. 2)

$$F_b = \gamma V_{\text{body}} = W$$

where F_b is buoyancy force, γ is the specific weight, V_{body} is the volume of the immersed body and W is the weight of the immersed body.

Fig. 2



3. (20%) Explain the following nomenclature, possibly an equation or a diagram is needed for a specific item.

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 本試題
共 2 頁
第 2 頁

- (a) Incompressible fluid flow (4%)
- (b) Irrotational Flow (4%)
- (c) Secondary flow (4%)
- (d) No slip condition (4%)
- (e) Stagnation point flow (4%)

4. (20%) A velocity field for specific flow is given by $\vec{V} = 10y^2 \vec{i} - 10xy \vec{j}$, please

answer the following questions (calculation is necessary for each item):

- (a) Is this flow irrotational? (5%)
- (b) Is the flow incompressible? (5%)
- (c) Find the acceleration field. (5%)
- (d) Find all non-zero rate-of-strain components. (5%)

5. (15%) A balloon is being inflated with a slow air supply of $0.6 \text{ m}^3/\text{s}$ (see Fig. 3).

Find the rate of growth of the radius at the instant when $R = 0.5 \text{ m}$. Note: you must use conservation laws and draw a suitable control volume.

6. (15%) The velocity distribution for an incompressible fluid in a pipe (Fig. 4) is given by the quadratic equation

$$V = V_{\max} (1 - r^2 / r_0^2),$$

where r is the radial coordinate, r_0 is the pipe radius and V_{\max} is the maximum velocity at the centerline. Please determine:

- (a) The relationship between the average velocity and maximum velocity. (5%)
- (b) The momentum correction factor β . (5%)
- (c) The kinetic-energy correction factor α . (5%)

Fig. 3

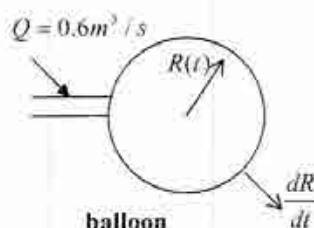


Fig. 4

